Honourcode, Inc.

Systems Engineering Return on Investment

SE-ROI Research

Near-Final Results Jun 10

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Funding provided by
- ***Honourcode, Inc.***
- ***DASI (Univ of South Australia)***

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Agenda

- **SE-ROI Project**
  - **Motivation: How much is enough?**
  - **Goals and methodology**
- **SE-ROI Results**
  - **Demographics**
  - **Primary Correlation Relationships: Success v. SE**
  - **Eight SE Activities**
  - **Right-Sizing SE**

Bottom Line

- **Better programs expend**
  - **more SE effort overall**
  - **more mission definition, more tech leadership**
- **All SE activities correlate well with**
  - **Stakeholder acceptance**
  - **Cost/schedule control**
- **No SE activities correlate with**
  - **System technical quality**

SE today leads to better programs – but does not lead to better systems.

- **Results can be used to right-size SE**

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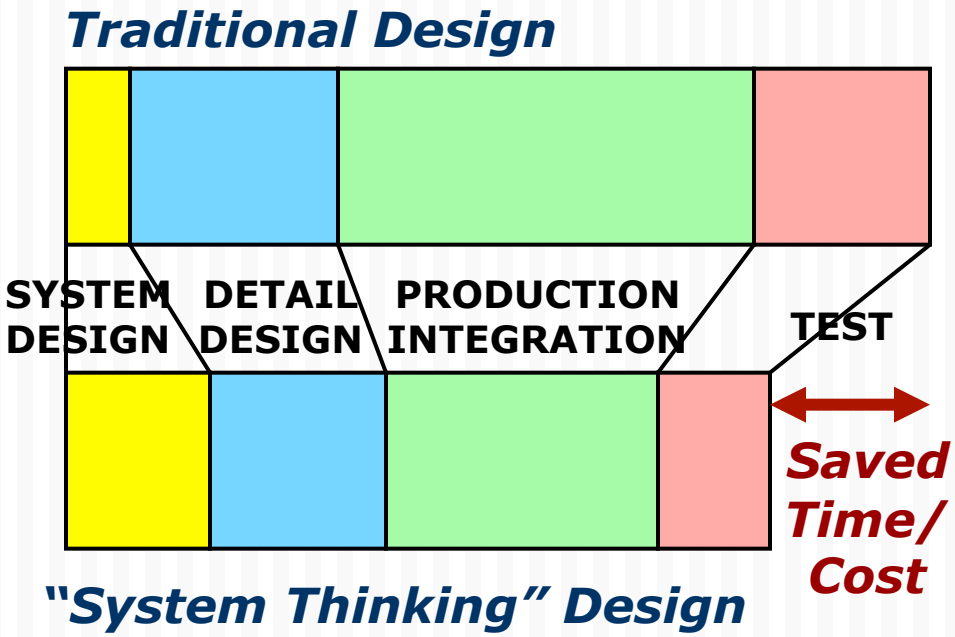
SE-ROI Project

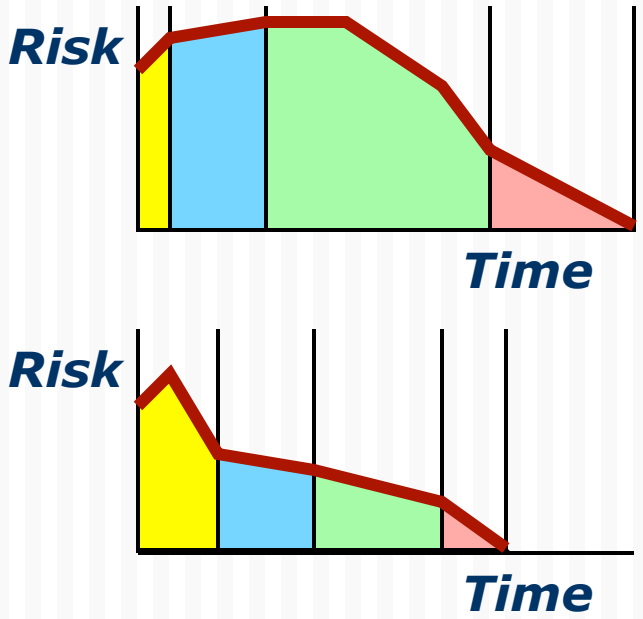
Methodology

Industry support

Heuristic Claim of SE

- **Better systems engineering leads to**
  - **Better system quality/value**
  - **Lower cost**
  - **Shorter schedule**





Not Known: How Much Is Enough?

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Project Goals

- **Research objectives**

  How Much Is Enough?

  - ***Find out how much of what type of SE correlates with project success***
    - **What SE practices are appropriate under what conditions.**
  - ***Leading indicators***
    - **Used during a project to assess the project's expected future success and risks based on SE practices used.**
  - ***Identification of good SE practices***
    - **Appropriate to generate success under different conditions.**
- **Schedule**
  - **'05-'07 – Technical structuring and definitions**
  - **Late '07 – Started data gathering**
  - **Internal reports '08–'09**
  - **Final reports '10**

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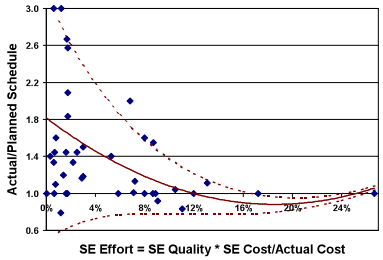
SE-ROI Project

Interviews

- **Just-completed programs**
- **Key PM/SE/Admin**
- **Translate program data into project structure**

- ***Program characterization***
- ***Program success data***
- ***SE data (hours, quality, methods)***

Statistical correlation



Desired Results

1. **Statistical correlation of SE practices with project success**
2. **Leading indicators**
3. **Identification of good SE practices**

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Company Participation

- **Data gathering** ***– minimal impact***
  - **Select 2 to 4 programs**
  - **One day of interviews**
  - **2-hour sessions with PM+SE of each program**
  - **Strong protection of proprietary data**
- **Reports** ***– effective program benchmarking***
  - **Benchmark report within 30 days of session**
    - **Compares programs against prior data**
  - **Quarterly reports from all prior data, all sources**
    - ***Correlations found***
    - ***Leading indicators proven***
    - ***SE practices proven***

Current Status – Jun 2010

SE ontology **from SE standards – wide-spread, acceptable terminology**	**Completed Oct 05**
Develop interest base **from possible interview sources (currently ~65)**	**Completed**
Create interview data sheets **and vet them through sample interviews**	**Completed Oct 06**
Start program interviews	**Started 3/07**
Gather data **from 40+ programs**	**Completed Sep 09**
▪ **Interviews held with 51 programs**	
Perform statistical analysis **to find correlative results**	**In process**
Report benchmark results **to participating organizations**	**In process**
Public reports **on research results**	**In process**

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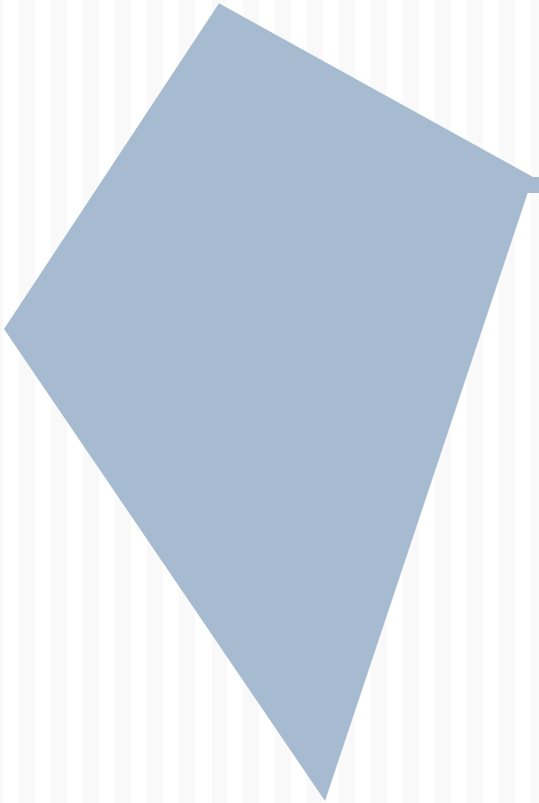
SE-ROI Results: Demographics



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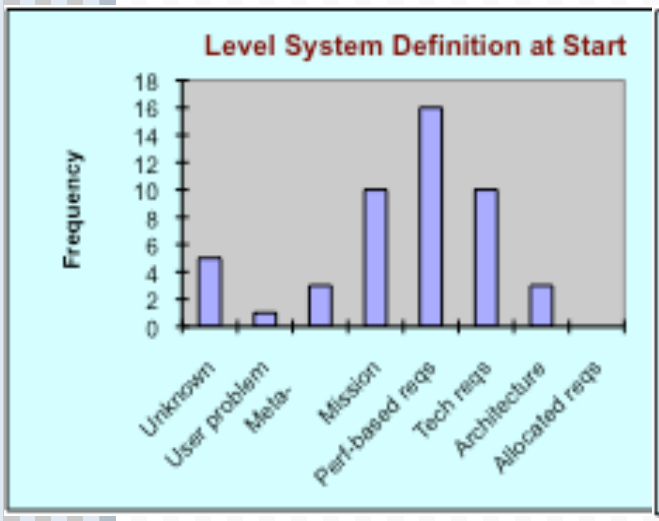
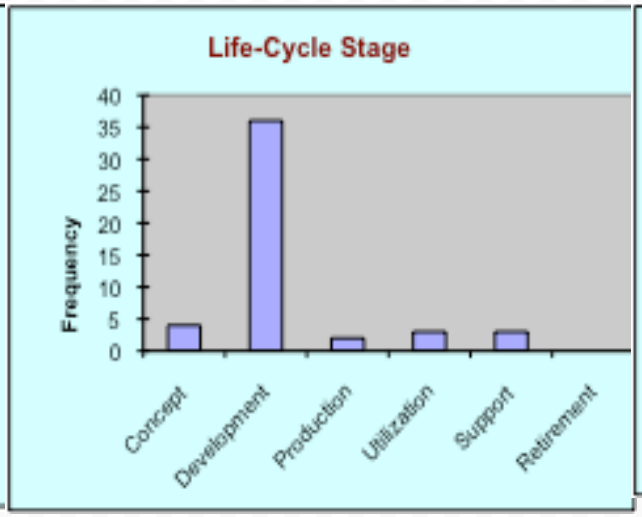
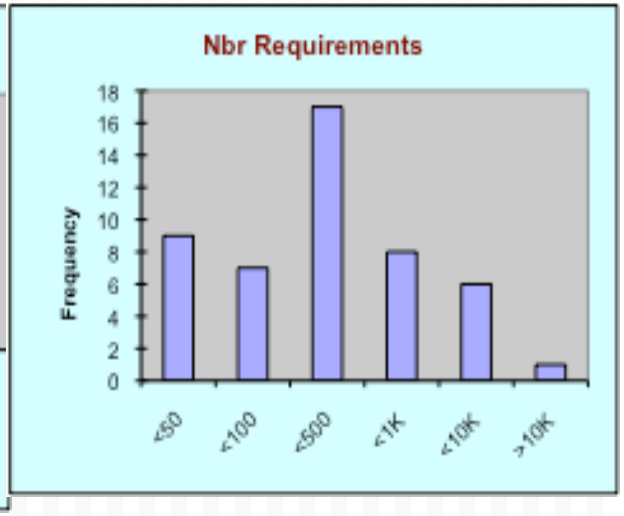
Basic Demographics

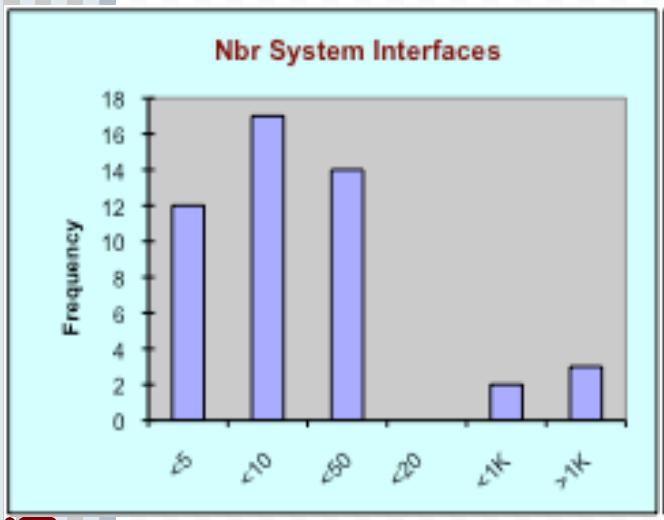
Characteristic	ValueSE Data Set	SE-ROI Data Set
Number of organizations	Unknown	16
Number of data points	44	48
Funding method	Unknown	39 contracted, 9 amortized
Program total cost	$1.1M - $5.6B Median $42.5M	$600K - $1.8B Median $14.4M
Cost compliance	(0.8):1 – (3.0):1 Median (1.2):1	(0.6):1 – (10):1 Median (1.0):1
Development schedule	2.8 mo. – 144 mo. Median 43 mo.	2 mo. – 120 mo. Median 35 mo.
Schedule compliance	(0.8):1 – (4.0):1 Median (1.2):1	(0.3):1 – (2.5):1 Median (1.1):1
Percent of program used in systems engineering effort, by cost	0.1% - 27% Median 5.8%	0.1% - 80% Median 17.4%
Subjective assessment of systems engineering quality (1 poor to 10 world class)	Values of 1 to 10 Median 5	Values of 1 to 10 Median 7

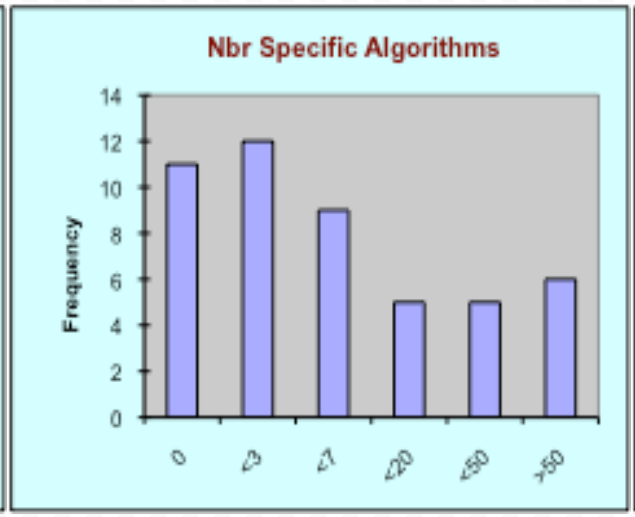
Program "Size"

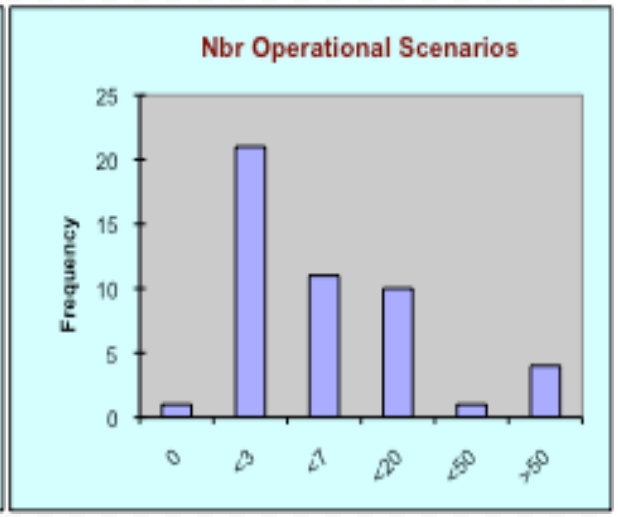












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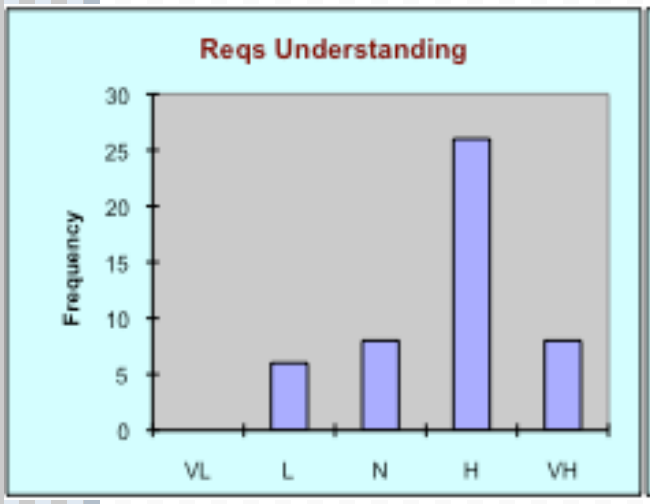
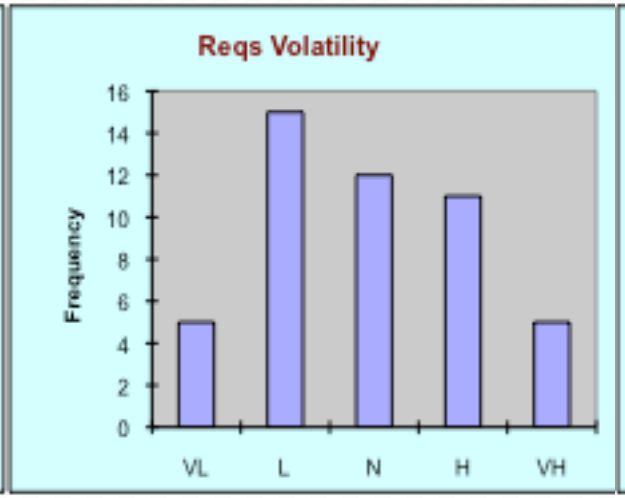
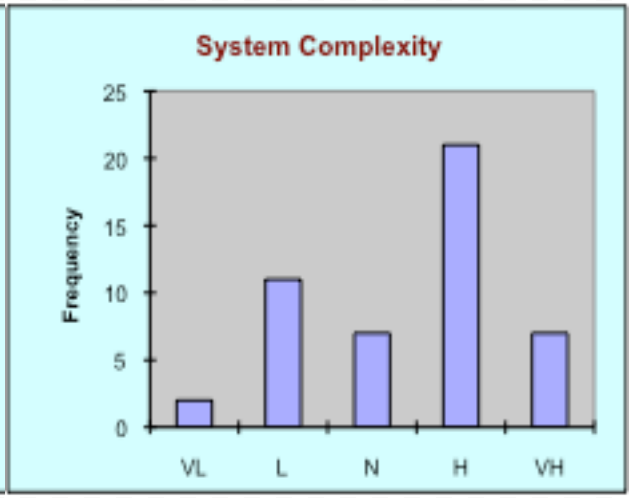
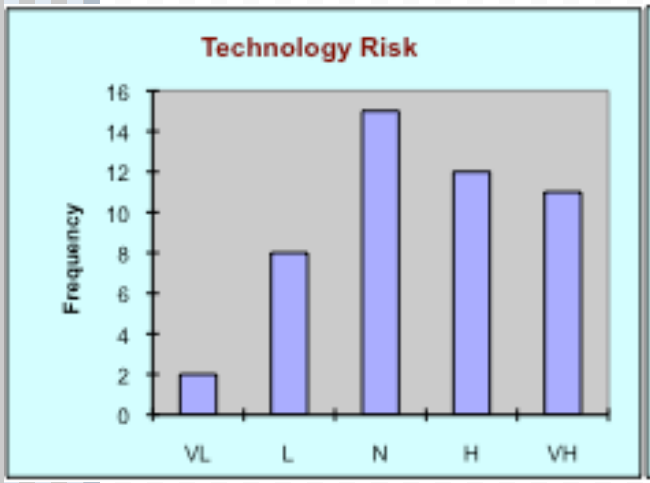
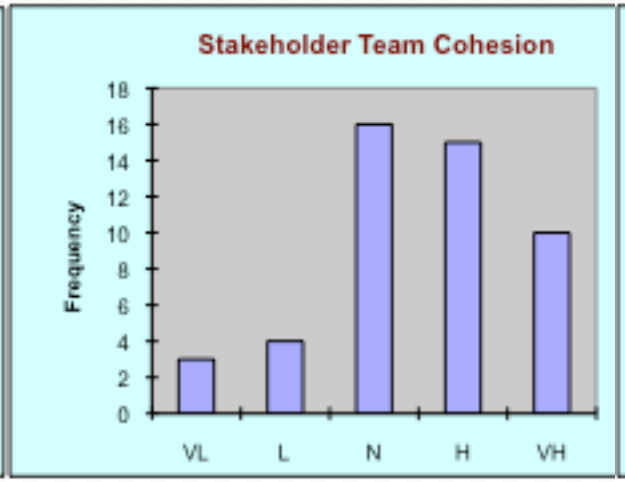
Program/Team Parameters

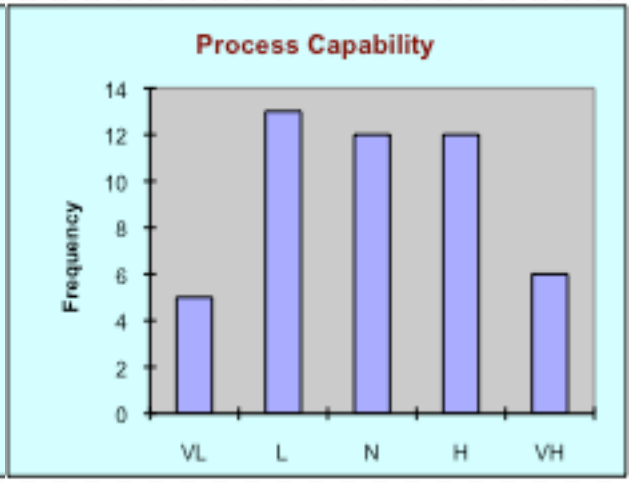












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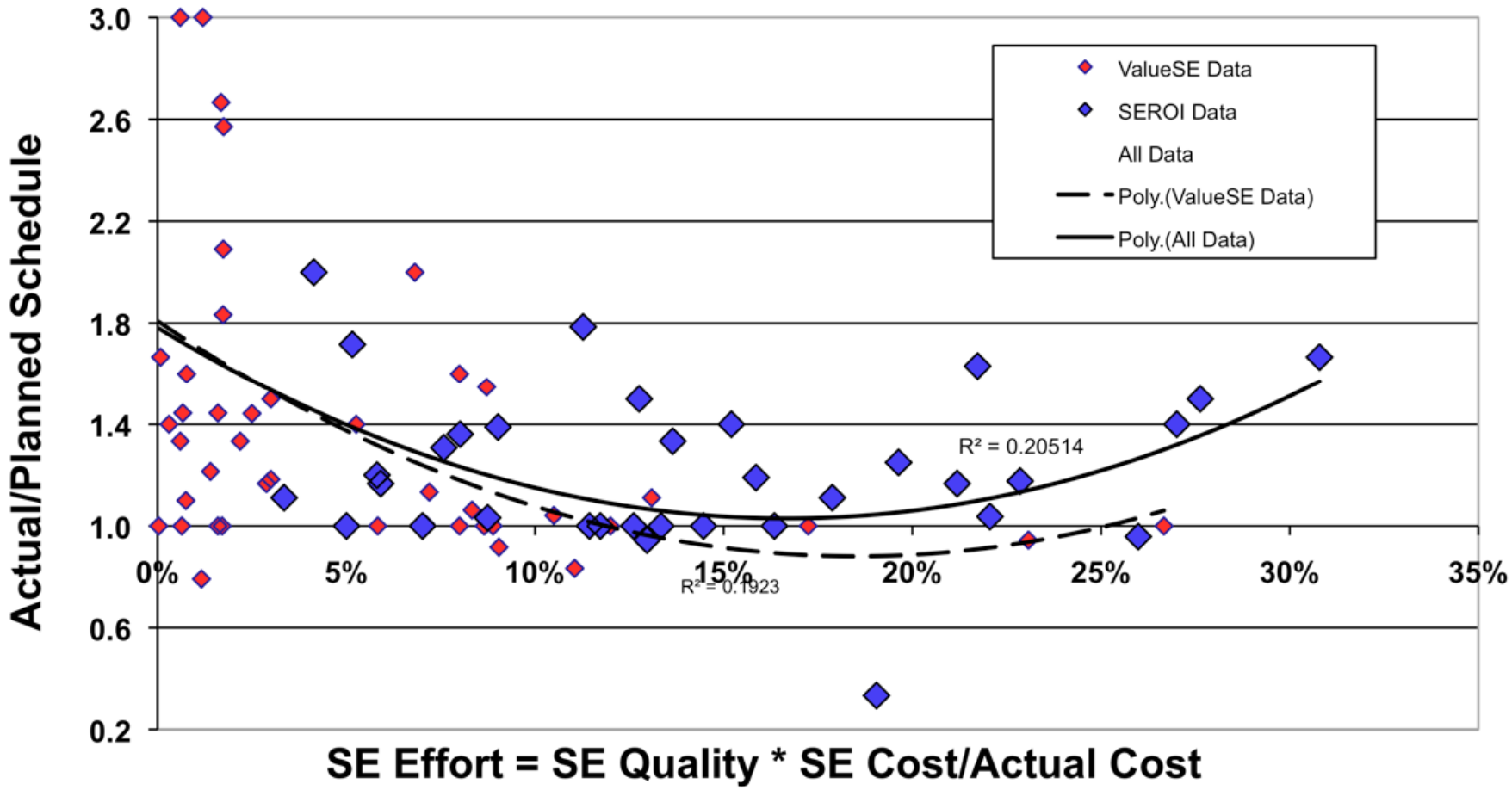
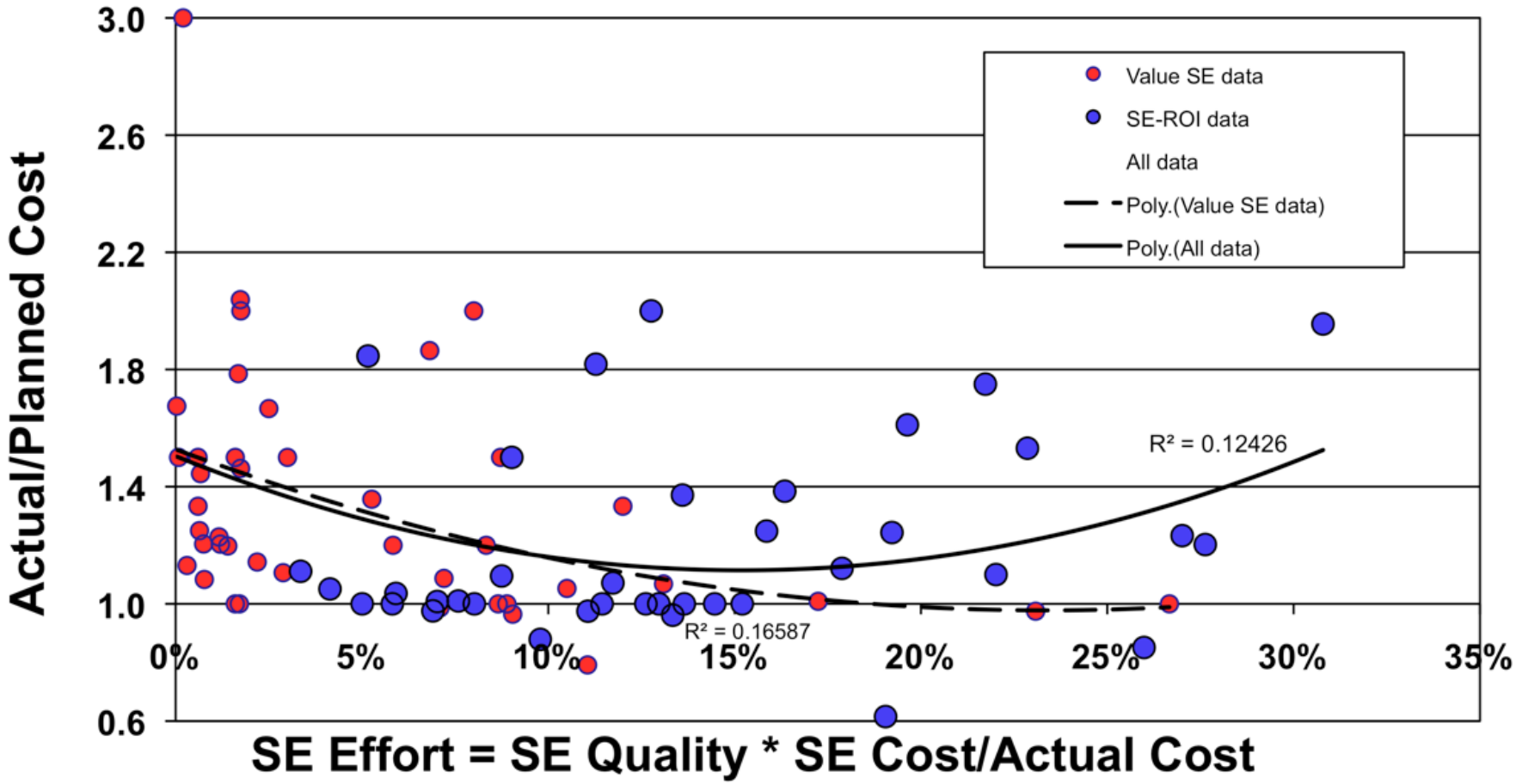
SE-ROI Results: Primary Relationships

Schedule vs. SE Effort



Cost vs. SE Effort



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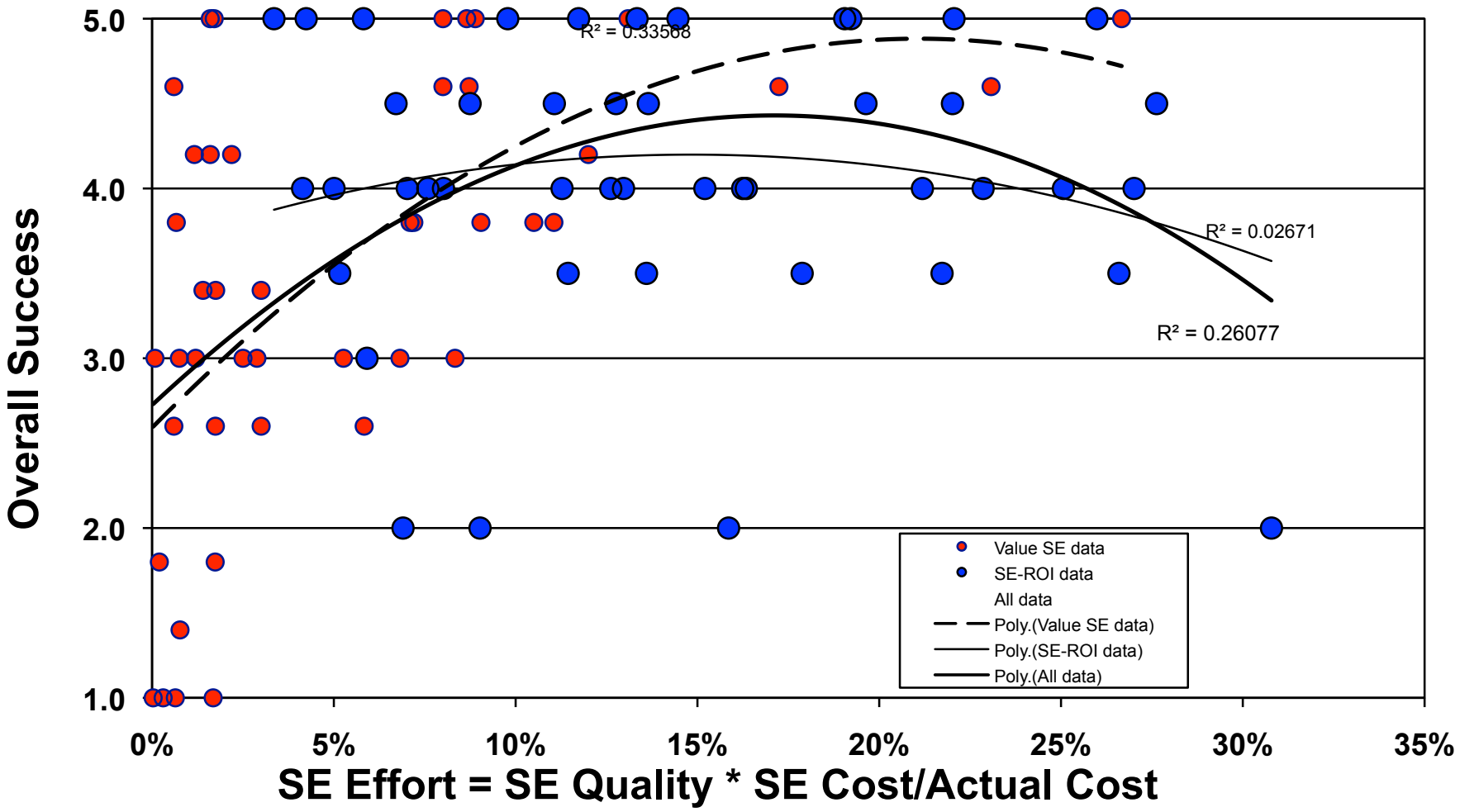
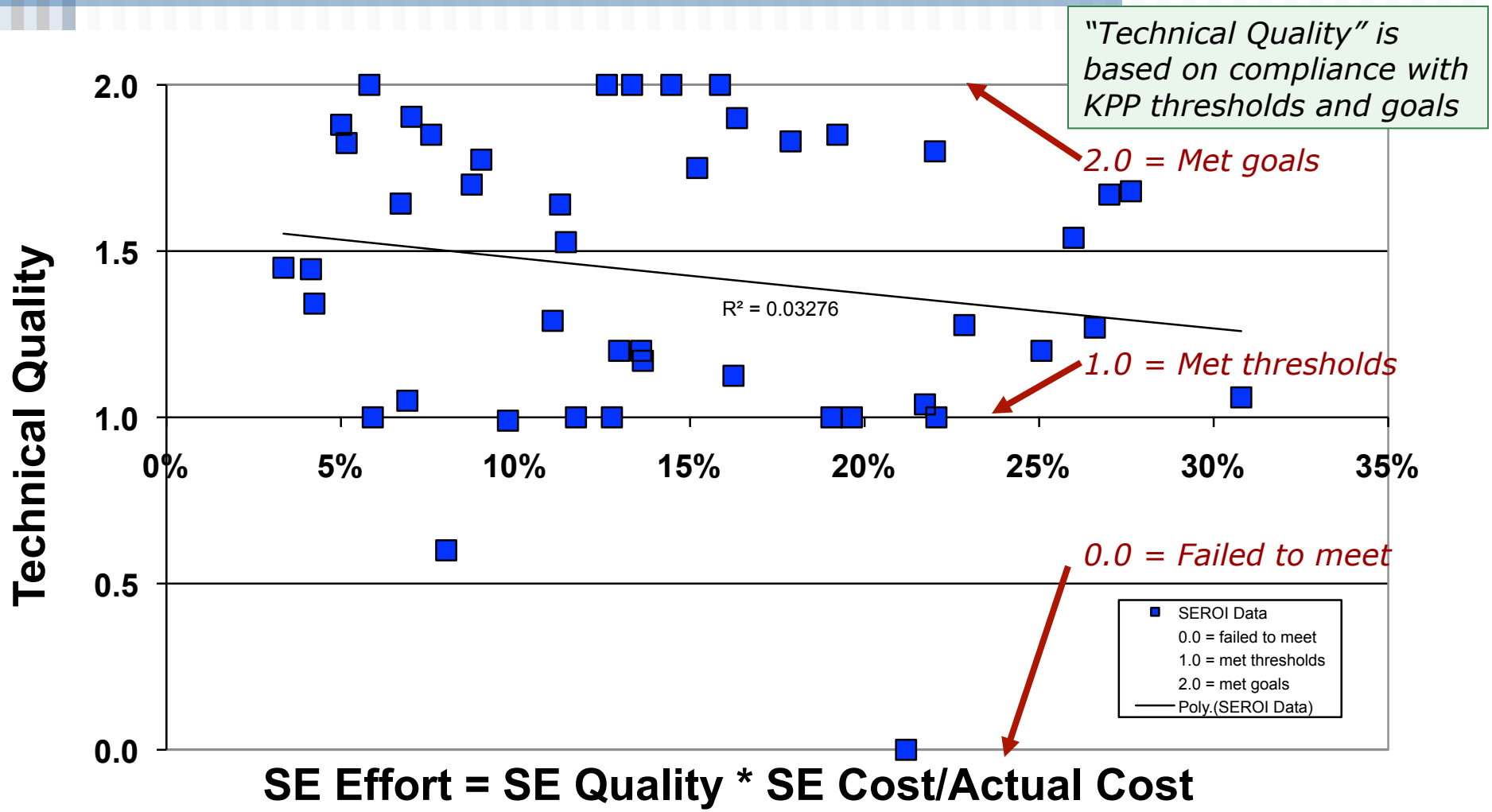
Overall Success vs. SE Effort



Technical Quality vs. SE Effort



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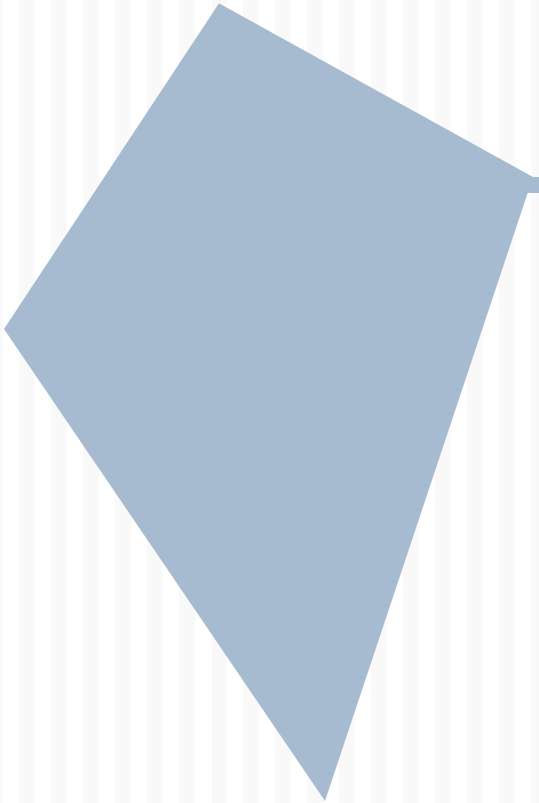
SE-ROI Results: Eight SE Activities



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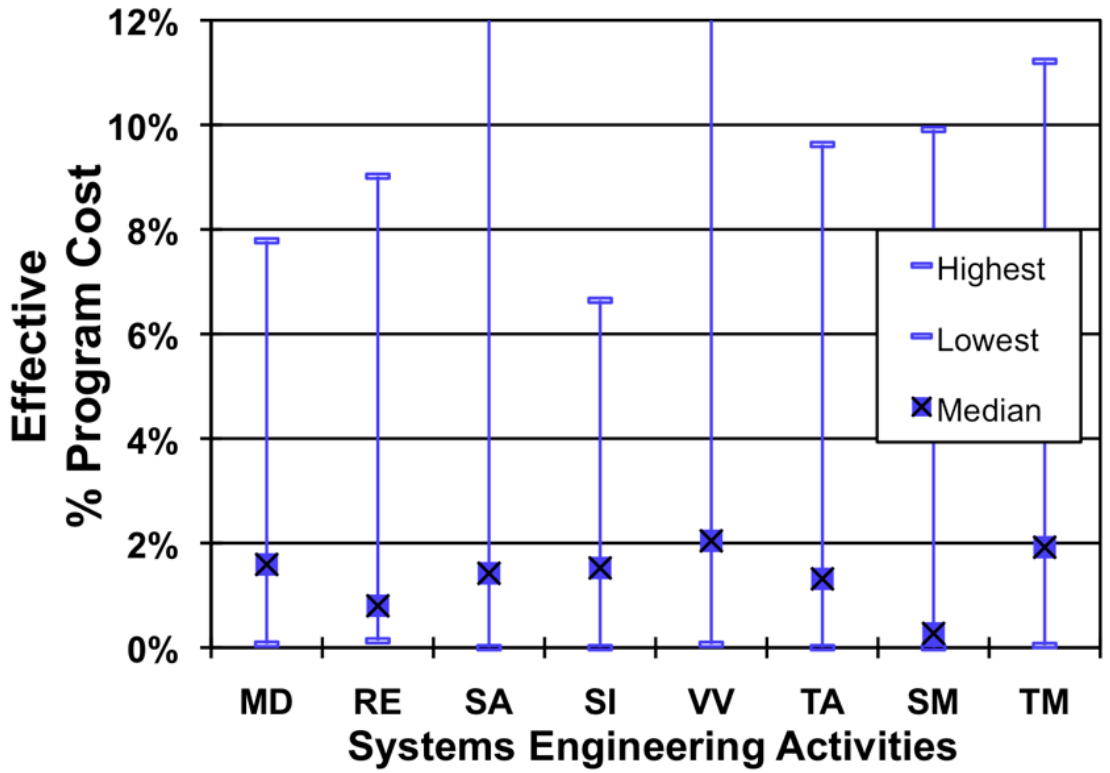
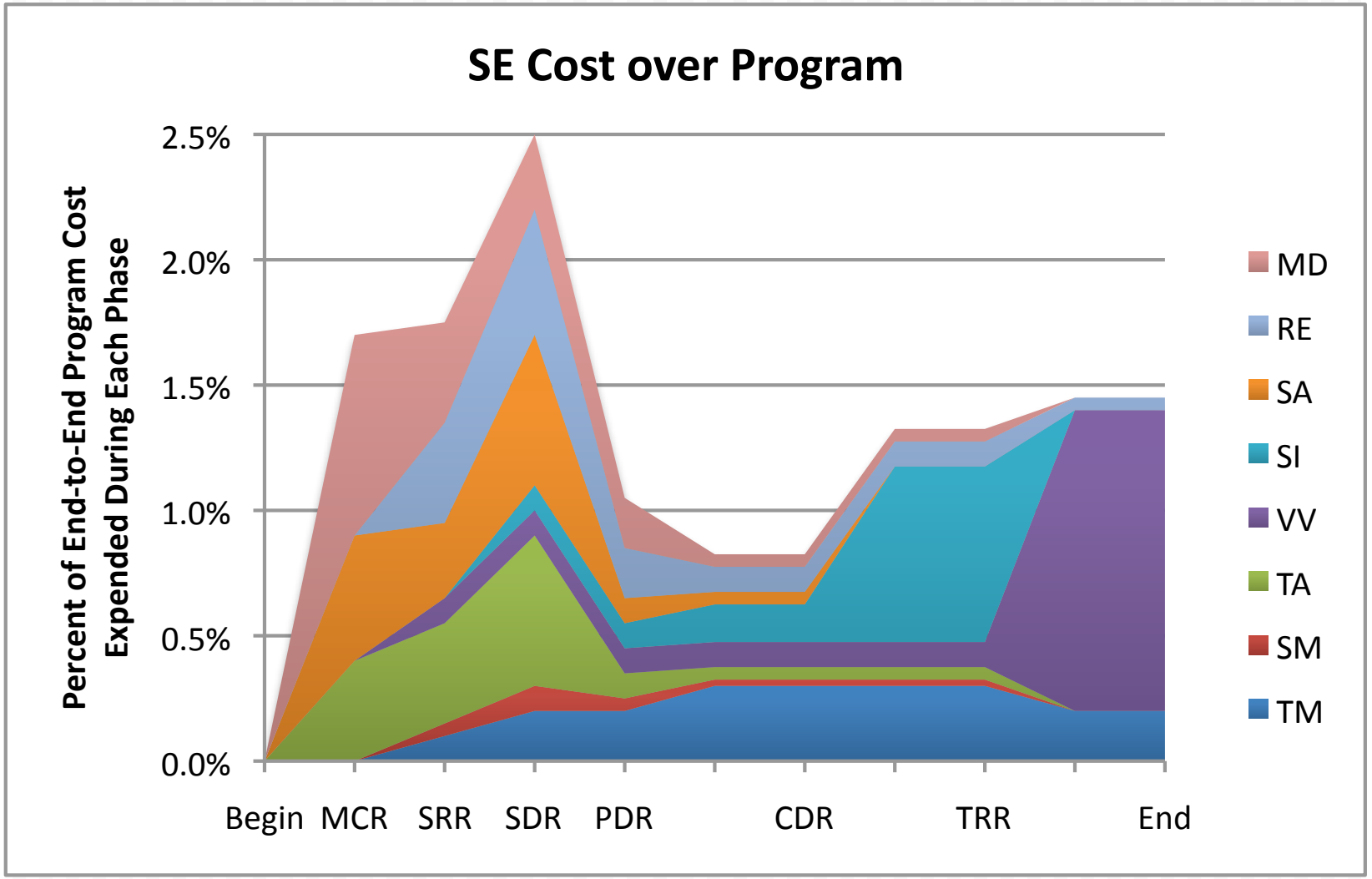
Breakout by SE Activities

MD Mission/Purpose Definition
RE Requirements Engineering
SA System Architecting
SI System Integration
VV Verification & Validation

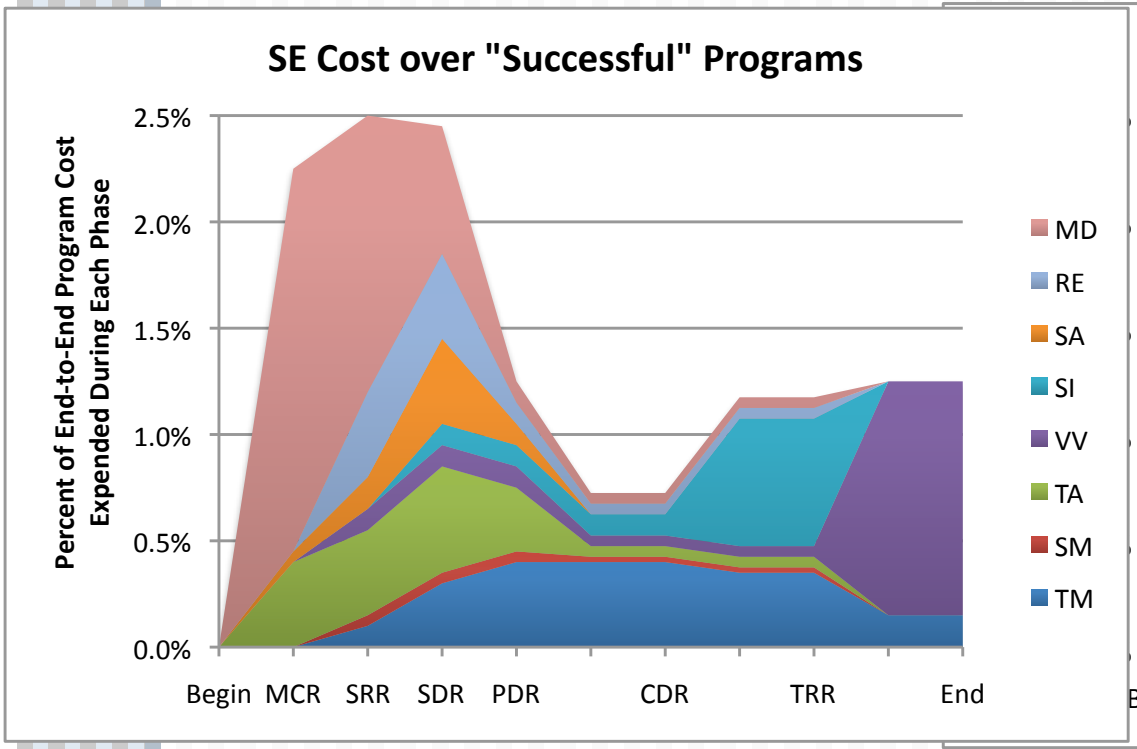
TA Technical Analysis
SM Scope Management
TM Technical Leadership/Management

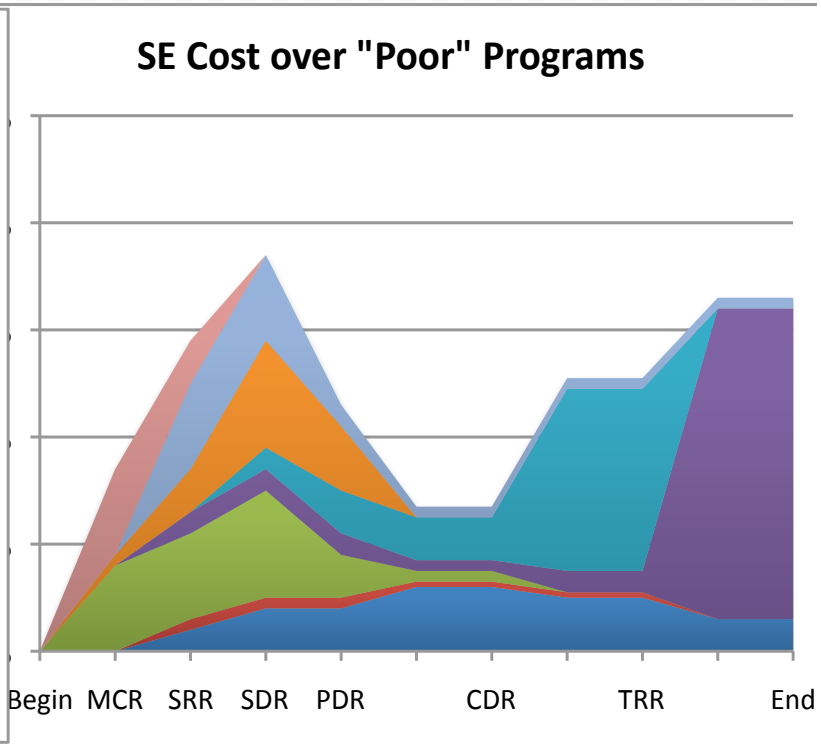


Breakout by Phase



Breakout by Success



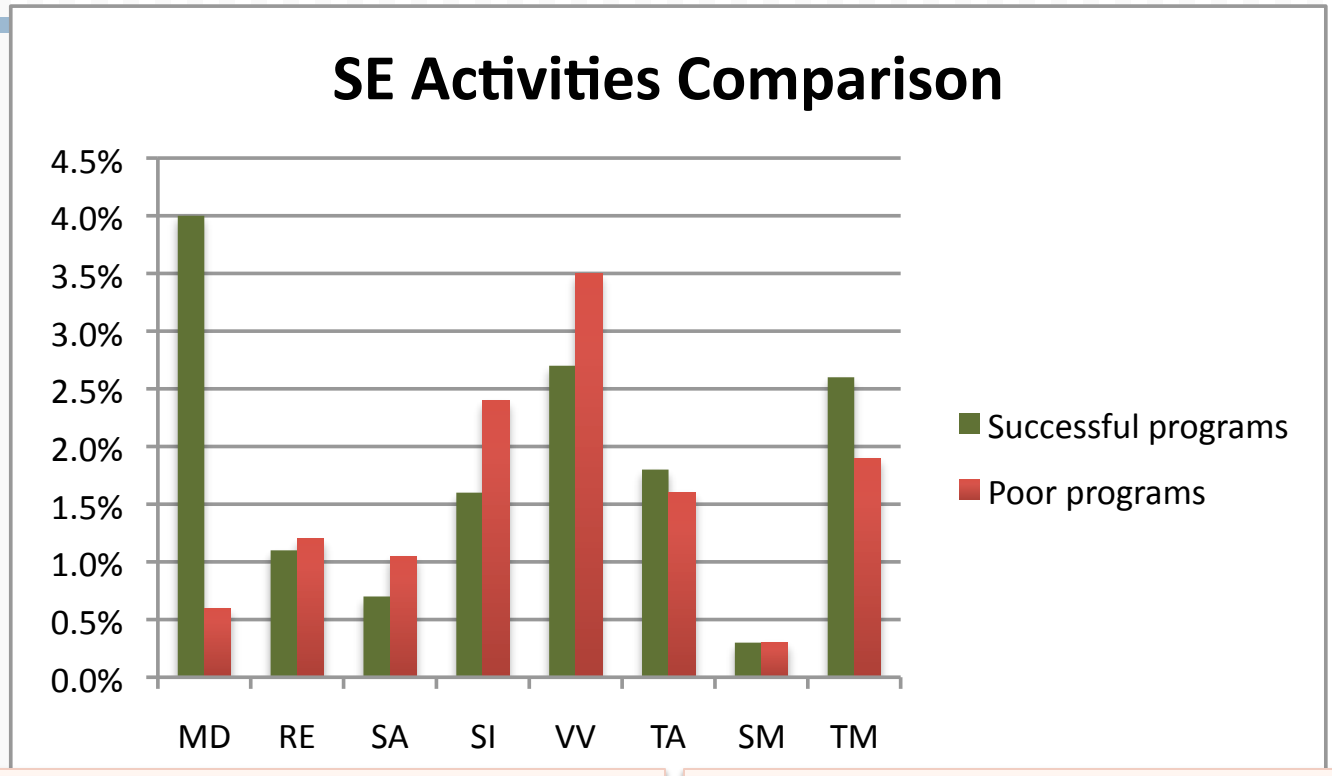


Successful programs
- More front end

Poor programs
- More back end

Success/Poor defined by median of cost overrun
- *"Success" programs are mostly on cost*
- *"Poor" programs are mostly overrun*

Breakout by Success

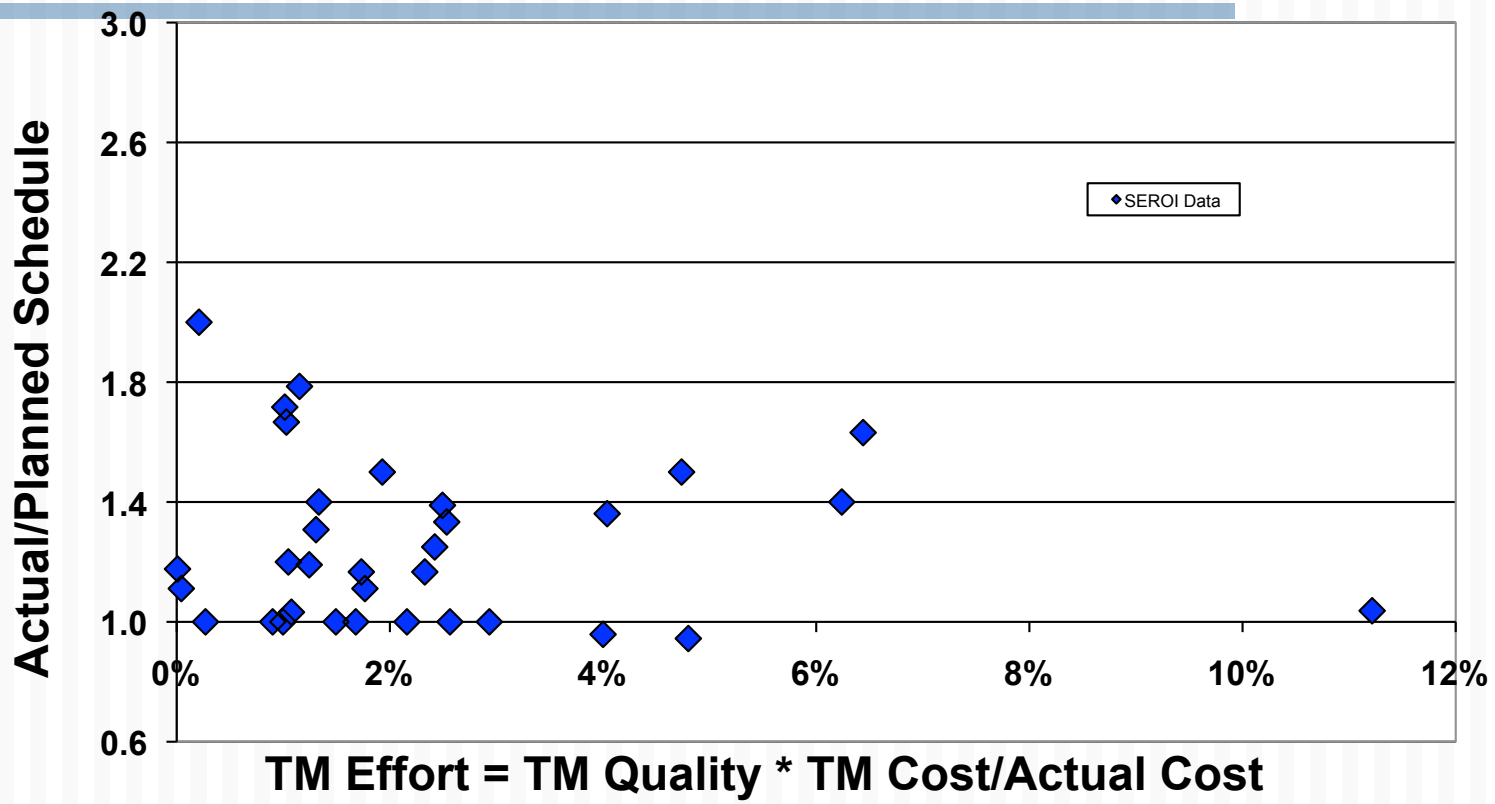


Successful
- More mission/purpose defn
- More tech leadership/mgmt
- More Systems Engineering

Poor
- More system integration
- More verif & valid
- Less Systems Engineering

Typical Data:

Schedule vs. Tech Lead'ship/Mgmt



Weaker visual correlation observed for:

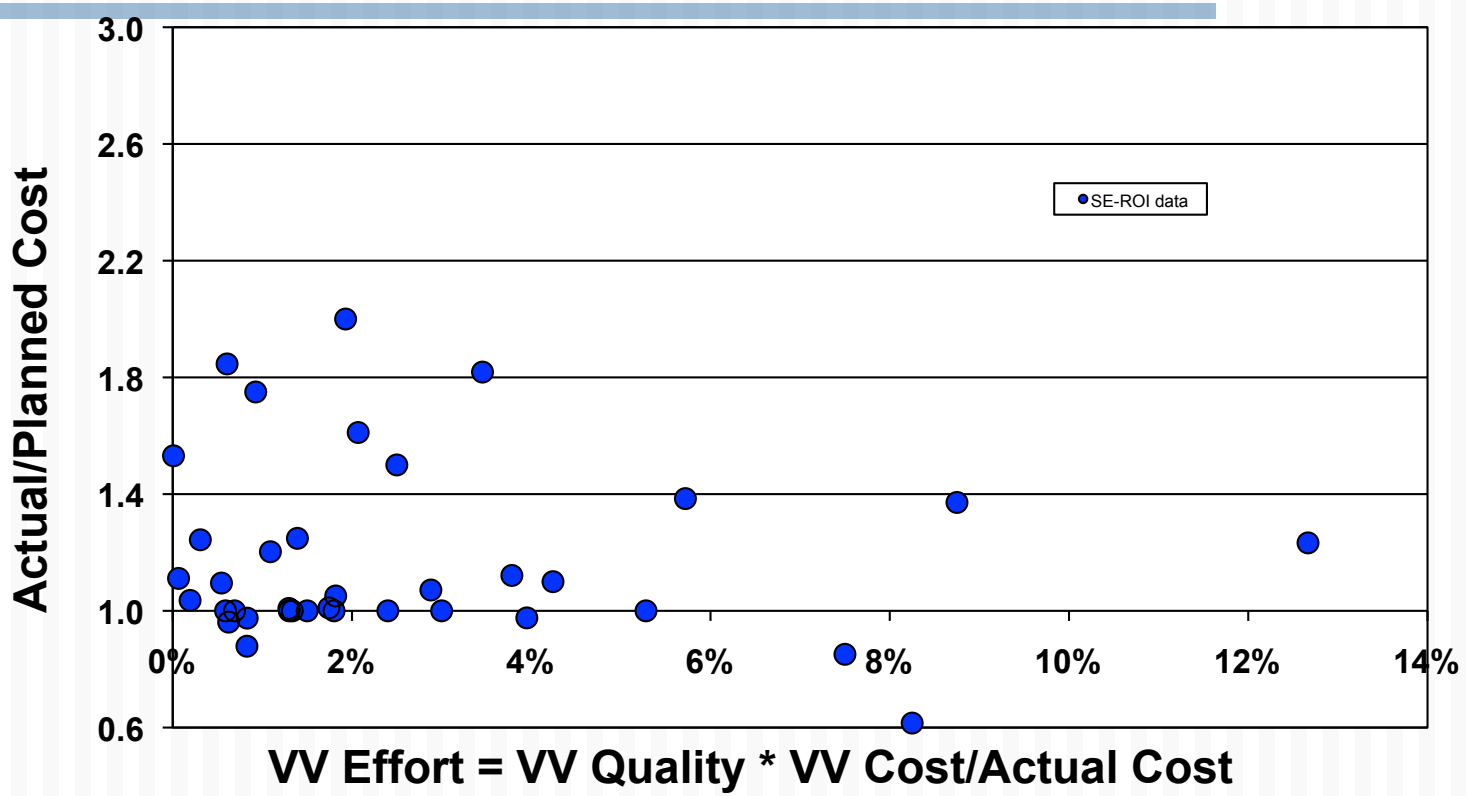
SI System Integration

Strong visual correlation observed for:

ALL other activities

Typical Data:

Cost vs. Verif/Valid



Weaker visual correlation observed for:

MD Mission Definition

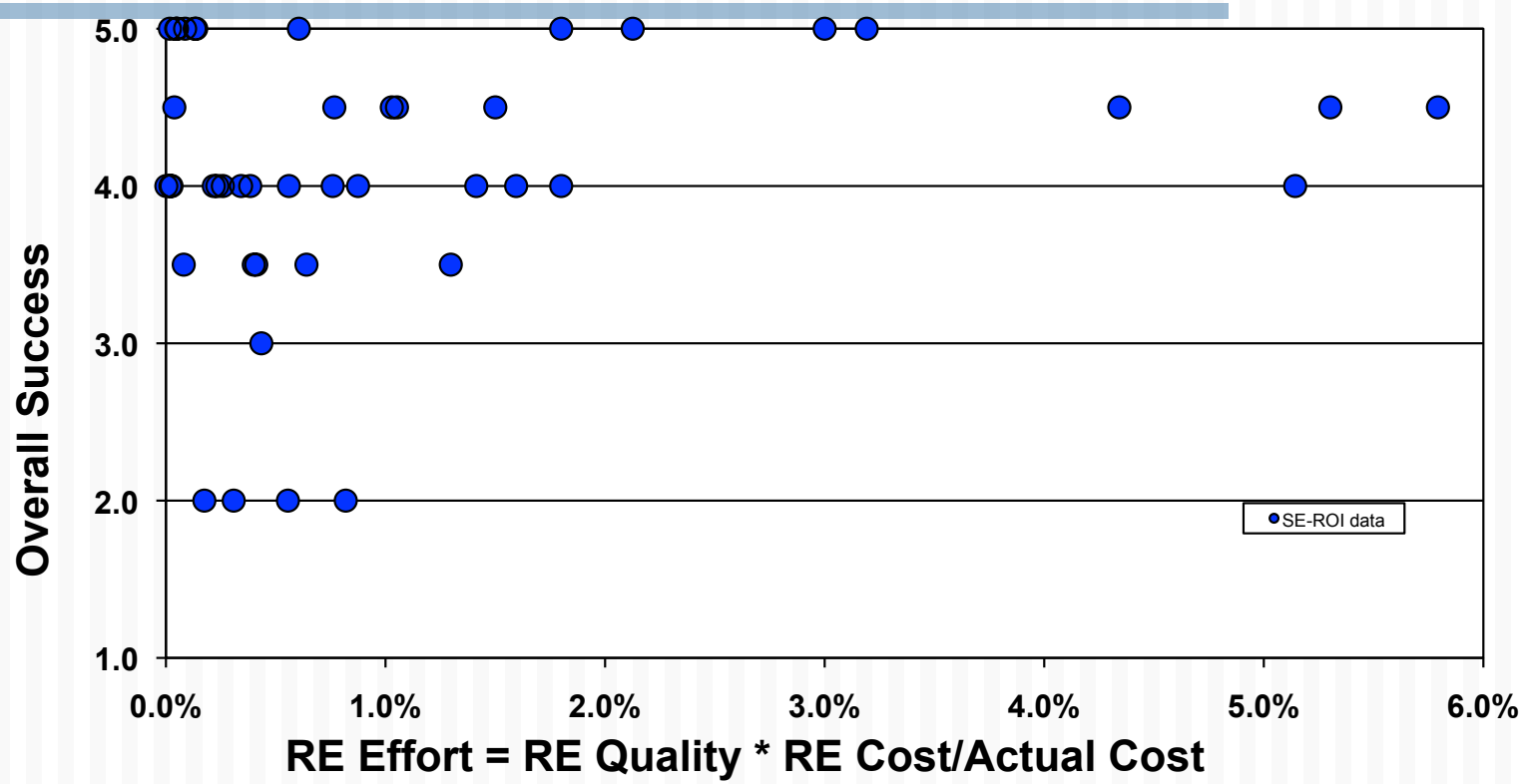
SI System Integration

Strong visual correlation observed for:

ALL other activities

Typical Data:

Overall Success vs. Reqs Engr

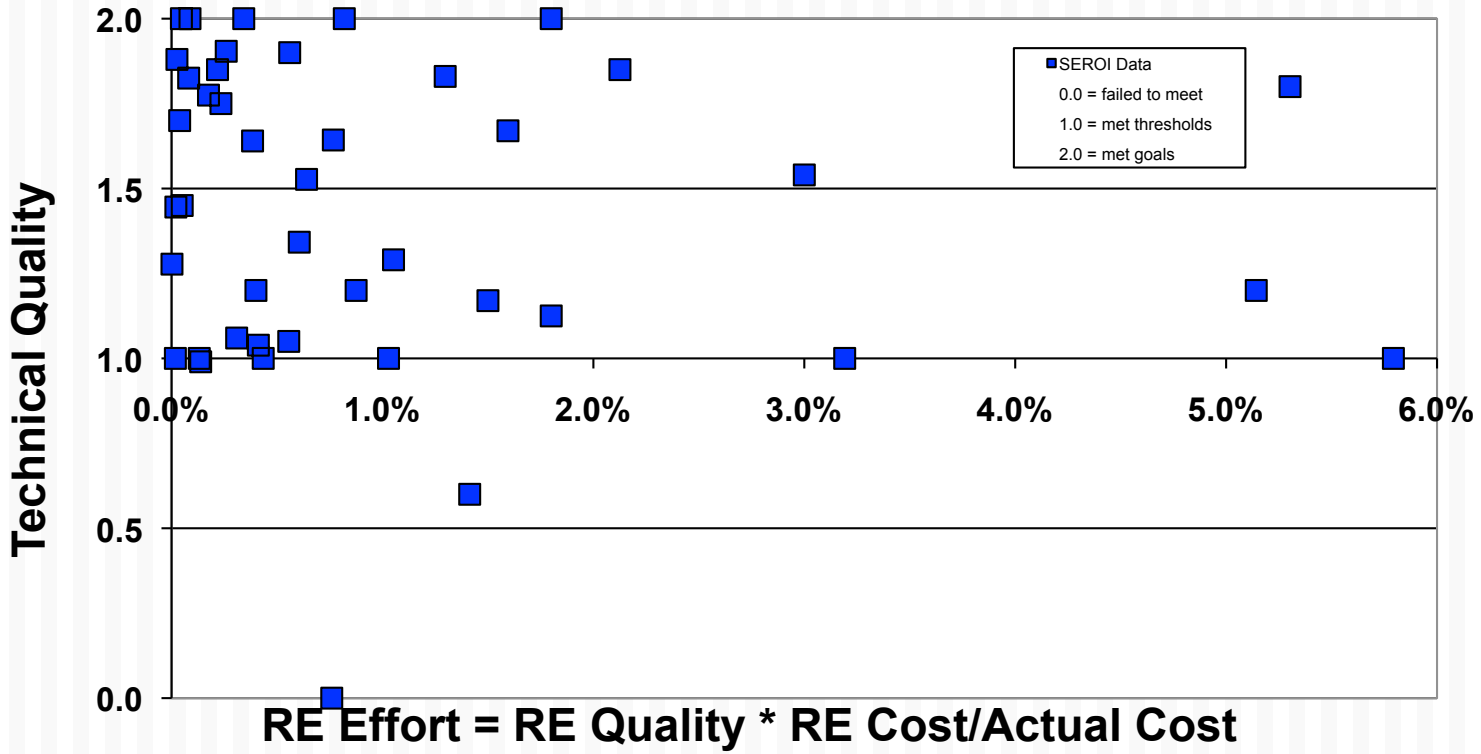


Weaker visual correlation observed for:
SI System Integration

Strong visual correlation observed for:
ALL other activities

Typical Data:

Tech Quality vs. Reqs Engr



No significant correlation observed for ANY activities.

Effect of SE Activities

- **Which activities correlate to better quality?**

Activity	Cost	Schedule	Overall	Technical
Missn Defn*	Perhaps	Yes	Yes	No
Reqs Engr	Yes	Yes	Yes	No
Sys Arch	Yes	Yes	Yes	No
Sys Integr	Perhaps	Perhaps	Perhaps	No
Tech Anlysis	Yes	Yes	Yes	No
Tech Mgmt	Yes	Yes	Yes	No
Scope Mgmt	Yes	Yes	Yes	No
Ver & Val	Yes	Yes	Yes	No

* *For most projects, MD was performed in an earlier phase*

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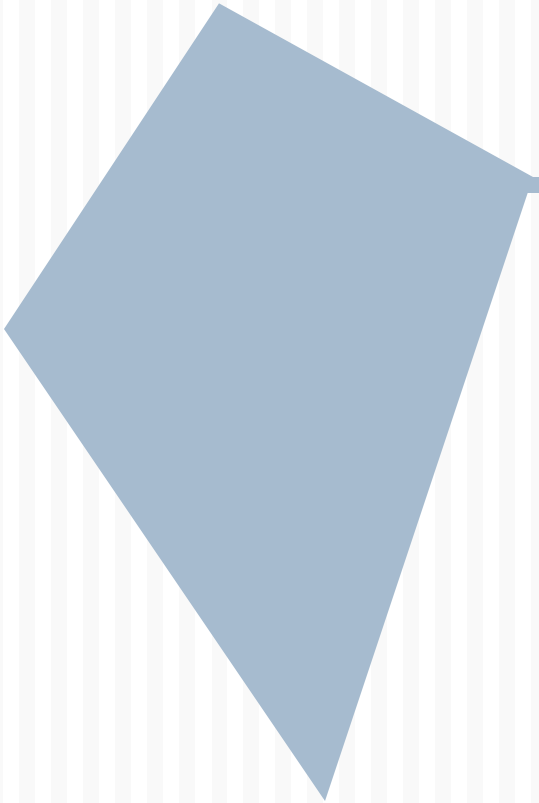
SE-ROI Results: Right-Sizing SE



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Adjustment to SE Effort

- **Raw SE percent of program cost**

$$SE\% = \frac{Cost_{SE}}{Cost_{PROGRAM}}$$

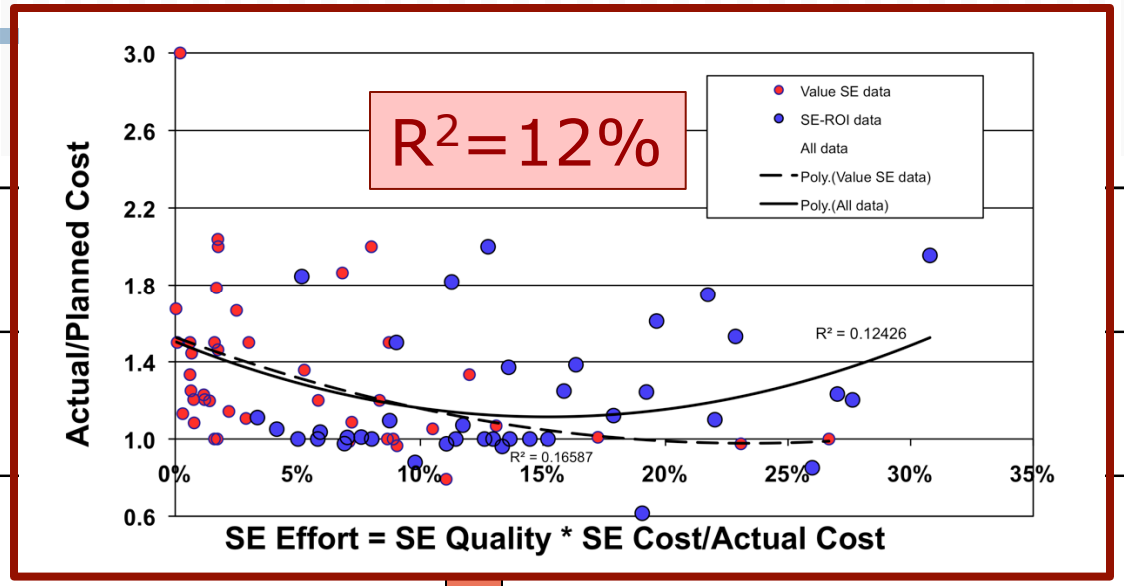
- **"SE Effort" - adjust for quality of SE**

$$SEE = SEQ * SE\%$$

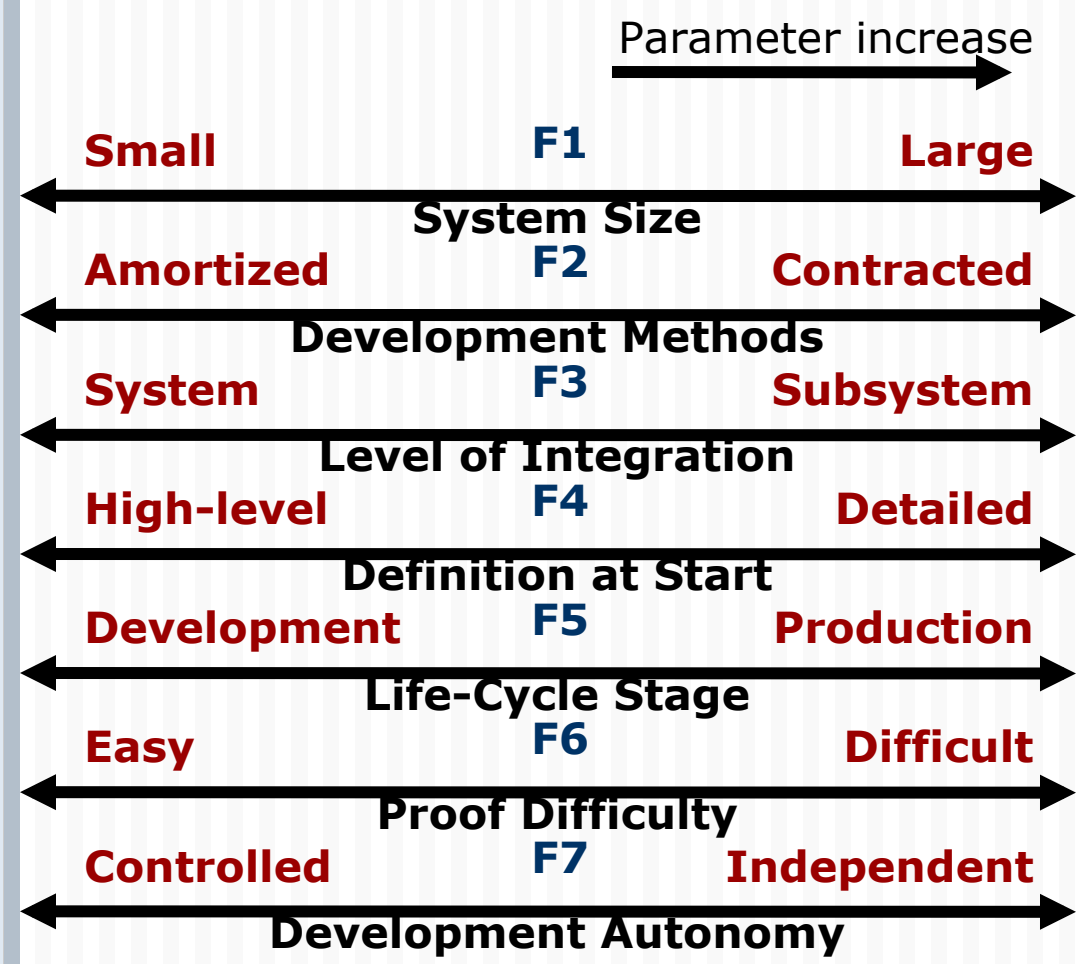
- **"Equivalent SE Effort" – adjust for 14 characterization parameters**
  - **Multiplicative factors as in COSYSMO**
  - **Select weights to optimize correlation**
  - **=0 for no effect; >0 to increase; <0 to decrease**

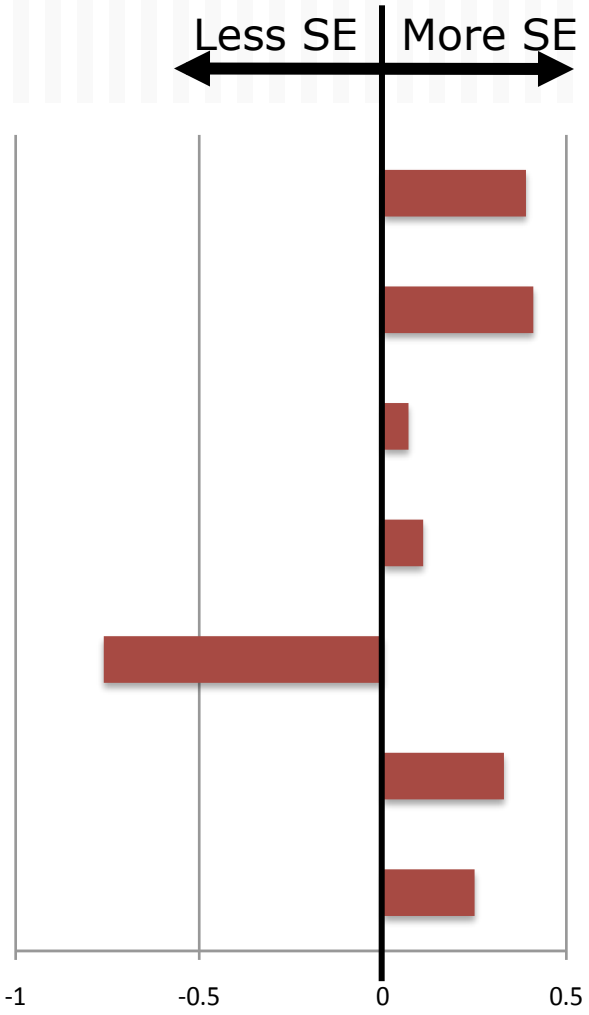
$$ESEE = SEE * \prod_{j=1...14} \left(\frac{PP_j}{.5} \right)^{Weight_j}$$

Effect of Characterization Parameters

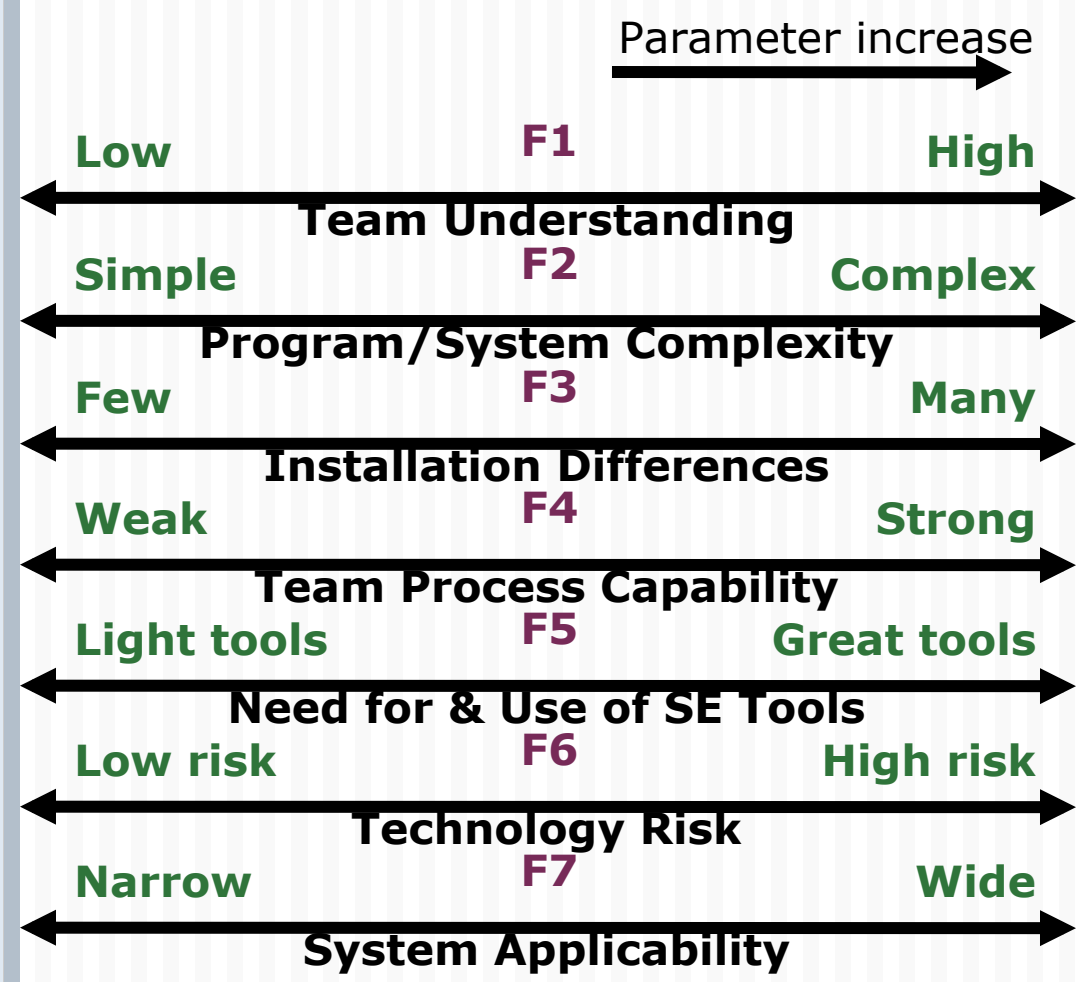


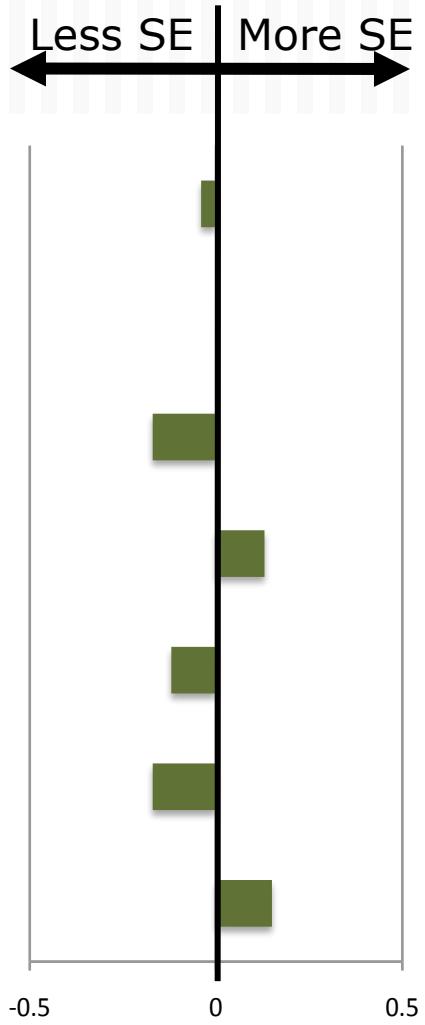
Quantified Parameter Weights





Subjective Parameter Weights





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Right-Sizing SE

- Find optimum level of ESEE for the success measure desired
- Estimate characterization parameters
- Estimate expected project SEQ
- Adjust SE level backwards

  (will be automated calculations)
  - Apply weights to optimum ESEE level to determine SEE level
  - Apply SEQ factor to determine SE% to use

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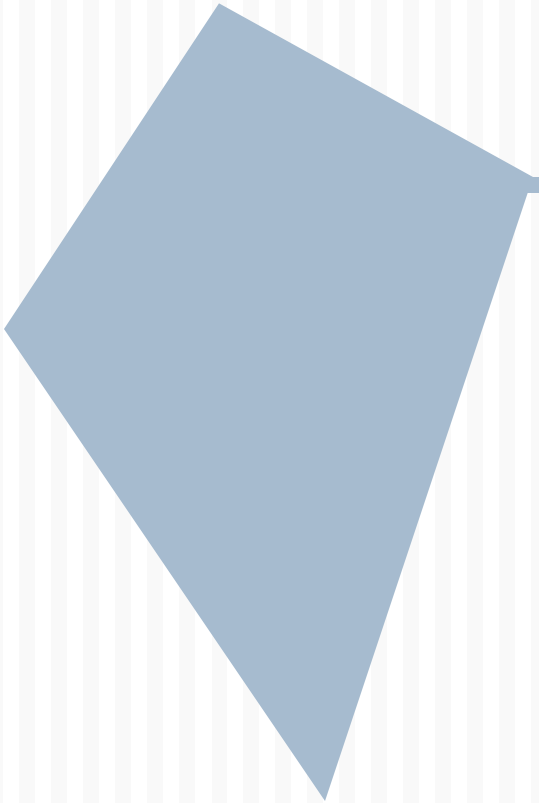
Summary



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Quantified, Proven Results

- **Better programs expend**
  - **more SE effort overall**
  - **more mission definition, more tech leadership**
- **<u>All</u> SE activities correlate well with**
  - **Stakeholder acceptance**
  - **Cost/schedule control**
- **<u>No</u> SE activities correlate with**
  - **System technical quality**

SE today leads to better programs – but does not lead to better systems.

- **Results can be used to right-size SE**

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Questions?

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